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18 September 1972

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Original: ENGLISH

Symposium on the Development of the Plastics
Fabrication Industry in Latin America

Bogotá, Colombia, 20 November - 1 December 1972

TWO COLOUR INJECTION MOULDING 1/

by

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SUMMARY

TWO COLOUR INJECTION MOULDING ^{1/}

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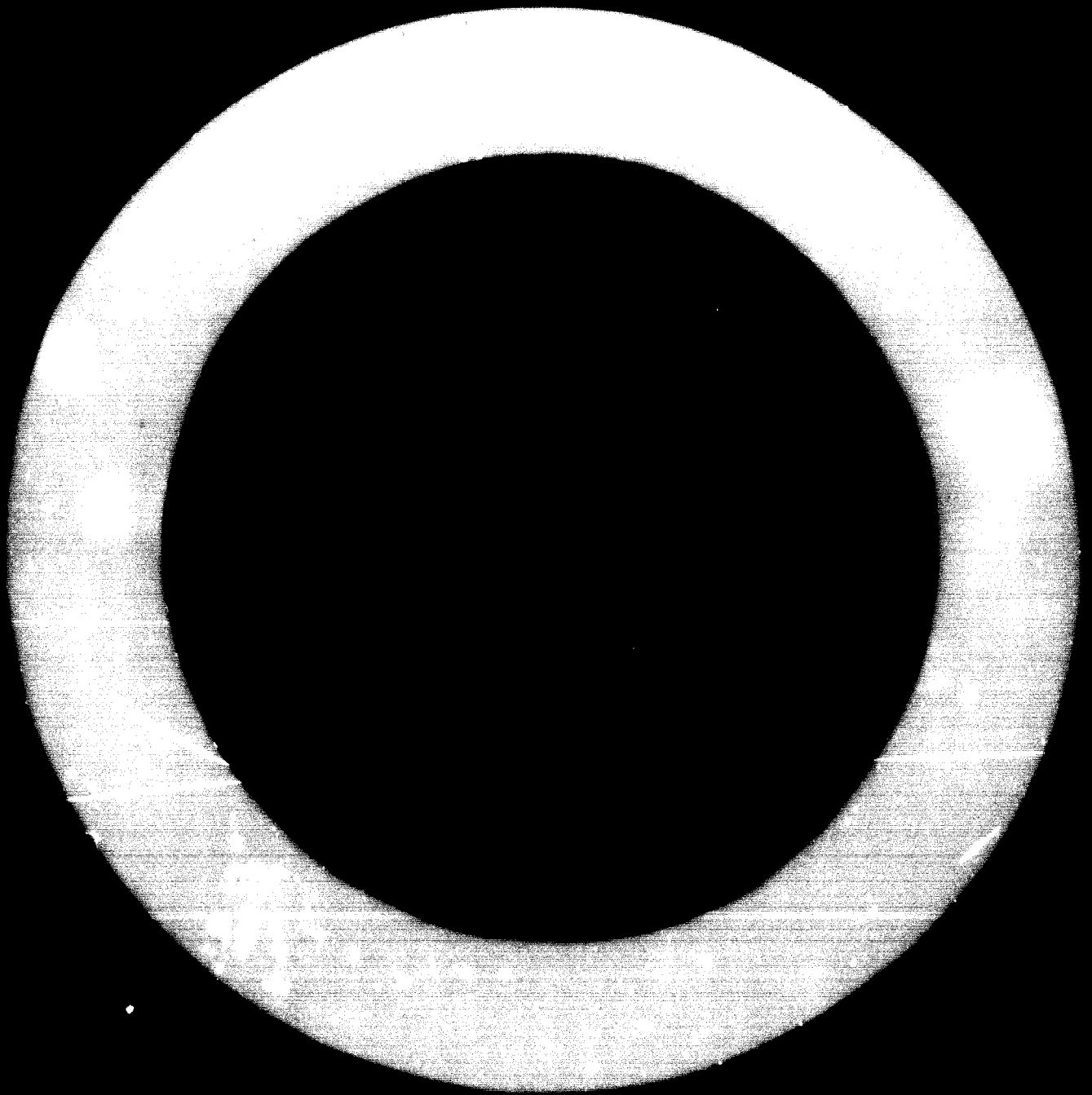
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The injection of thermoplastic articles in two colours, both for household and technical applications is growing in importance, being used for household articles such as two colour cups, beakers, plates, etc., allowing a wide scope in the colour design and in the technical field e.g. for two colour rear lights and keys for typewriters, computers, etc.

By the conventional method two colour articles are produced in two completely separate working operations. There is a wide percentage of rejects with this method as it is difficult to obtain a perfect binding of the two materials, due to shrinkage of the basic part during the period between injection operations and possible dirt particles.

The modern two colour moulding machines are an advanced form of the normal injection moulder and consist of a locking unit and two injection units, designed for high capacity screw plasticization. Both injection units can be adjusted individually, that means that simultaneously each cylinder can process a different material. The

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injection pressure, speed, operation time and temperature can also be set individually.

The production of the two colour part is fully automatic. The first colour is injected in station 1. Then the basic part is rotated by means of a hydraulic operated plate to station 2 and the second colour is injected, at the same time another basic part is being injected at station 1. If required, a shuttle plate can be used instead of a rotating plate, e.g. for the production of keys for office machines. The two colours are produced in one working operation using a 20 - 26 cavity mould, ejecting keys completely free of burrs, sprue and with a tolerance of $\pm 0,01$ mm. A special unit is used for fully automatic removal and sorting of the keys.

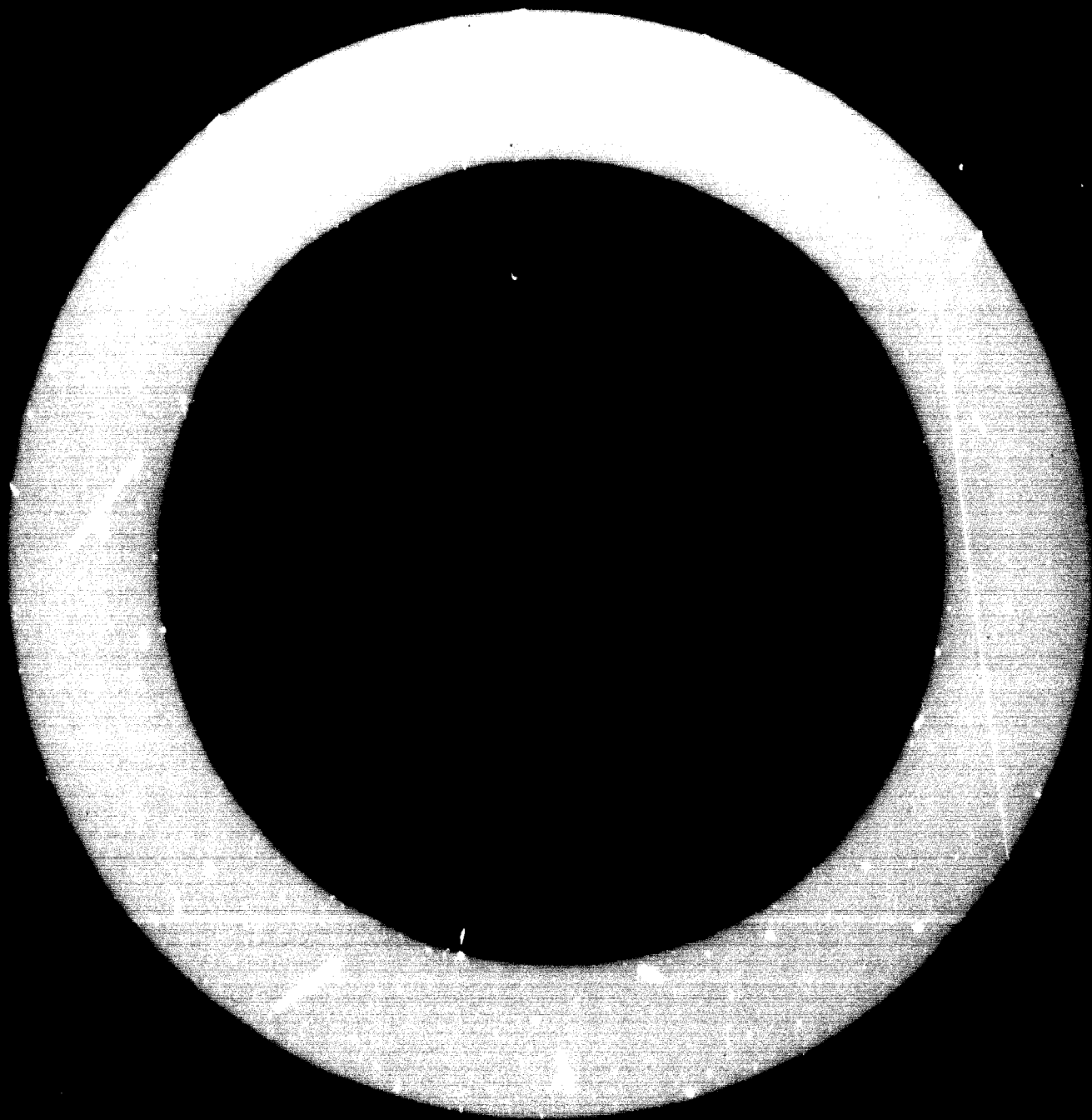
The advantages of the two colour injection moulding machines are high production figures and universal applications.

The machines can be applied for

- 1.) injection of one part in two different colours
- 2.) injection of two different or two identical parts in one working operation
- 3.) simultaneous or intermittent injection from two cylinders in one mould

enabling the best possible usage to be obtained.

In the paper the very good economic possibilities of the two colour injection of household articles will be pointed out, using the production of household articles as an example. Whereby in addition to the technical concept of the machine special emphasis will be laid on the possibilities for the automation of this processing method.



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I. INTRODUCTION

The injection of two colour parts from thermoplastic materials is growing rapidly in importance not only in the household sector but also in the technical field.

In Europe, the increase in the use of plastics in the household for utensils and electrical appliances etc. was a direct result of the tremendous demand for these articles after the second world war.

Material suppliers and material processors played a major part in creating the present day market. By improving quality and design they enabled production costs to be lowered, at the same time producing articles that were both attractive and robust.

Generally speaking Polyethylene, Polypropylene and Polystyrene are used for making utensils and electrical for making cooking spoons, kettles etc, whereby an unlimited choice of colours is possible. Last but not least the freedom of colour, which the production of household articles in plastic allowed, played an important part in the increased demand. As shown in Fig. 1, by using combinations of different colour combinations on the inside and outside surfaces, the two colour articles in particular gives the producer an unlimited range of design possibilities.

This paper deals with the fully automatic production of articles in two colours, using a 2 colour injection moulding machine.

II. PRODUCTION METHODS

A. Manual method of producing articles in two colours.

The necessity for the construction of a machine of this type was brought about by the uneconomical production methods used between the years 1939 to 1942 by various producers of 2 colour plastic articles.

two moulds and in most cases two standard types of machines were needed for the production.

The basic part or first colour was produced on one of the two machines, then removed and transferred to the second machine where the injection of the second colour took place, thus producing the finished article. Companies who only had one machine at their disposal were forced to an even more complicated system. The basic parts had to be kept in stock until at some later date, when the mould had been changed, it was possible to inject around them.

There were a high percentage of rejects with this method of production as it was not always possible to obtain a perfect joining of the two materials. This was made even more difficult by the cooling and subsequent shrinkage of the basic part between injection operations as well as by the dirt picked up during storage.

B) Method of production by two colour injection

As far back as the states Mass. Engel took steps to improve this long and uneconomical process by designing and constructing a 2 colour injection moulding machine. Therefore it can truthfully be said that Engel was one of the first companies to develop and put this type of machine on the market.

The design and construction have been so developed and refined over the last 10 years that today the machines are in great demand, even more so since it has been found that they can be used in the technical field.

At the present time the machines are being used in this field mainly in the auto-industry where all types rearlights are being produced quickly and relatively cheaply.

There are various types of construction for the mould fixing plates. For the injection of simple parts, rotating plates which turn 180° , are used. Then there are rotating plates which turn 360° in three stages. These are excellently suited for the automatic removal of the injected parts, whereby in station I the first, in station II the second or final injection takes place and in station III the finished part is removed from the machine.

Figure 2 shows a rotating plate, complete with mounted mould for the production of two colour covers for an electrical appliance.

The working operation of the normal 2 colour injection process is as follows:

2 Moulds are mounted on the rotating plate, by that we mean the basic mould and the finishing mould. Station I is injecting for example a white basic part and at the same time station II is injecting for example a red material over a previously injected white basic part. As soon as the cooling time has finished the locking unit opens and the finished part with the sprue is ejected from station II.

Only the sprue of the basic part is ejected from station I. The rotating plate is then turned 180° transferring the basic part from station I to station II. Then mould closes and the cycle starts once more.

It is easy to see the tremendous advantages of this method compared with the old method.

The main points being:

Fully automatic production, perfect binding of the two parts, reduction of the percentage of rejects, cuts out the necessity of storing the half finished product, a 100% production increase and at the same time a saving of personnel.

The advantages of these machines can also be seen when technical articles are being produced on them. In most cases it would not be possible, without the 2 colour machines, to produce the parts required for the automobile and office machine industries.

If for instance you examine the making of the rear light for cars, which are made entirely out of difficult to process materials such as (PMMA) Polymethylacrylate, Polycarbonate etc., then you can see that these could not possibly be bound together satisfactorily using the hand insert method.

The same applies for the production of typewriter or computer keys which firstly due to reasons of productivity can only be made using a fully automatic operation and secondly for technical reasons cannot be made at all using the hand inserting method.

C) The production of two colour finger keys for office machines:

This process gives a good example of one of the possible uses for a two colour moulding machine. The production takes place on a two colour machine with automatic removal and sorting unit using a system which has been patented by Messrs. Engel.

In this case the machines are equipped with a shuttle plate instead of a rotating plate. The two colour keys i.e. white - black or any required colour, are produced in a 20 to 26 cavity mould in one manufacturing operation. This means, using two mould, a complete set of keys for the standard typewriter can be produced rationally, without problems. Rational, because the keys, using the patented Engel system, are ejected from the machine sprueless, with absolutely no burrs and with a tolerance of 0,01 mm. These materials are very hard and have a good resistance against scratching.

An automatic removal and sorting unit which is synchronized with the machine, takes care of the removal and sorting of the keys. The unit also insures that there is no chance of them being damaged after they are ejected from the machine.

The cycle times are in the region of 30 secs, which gives between 40 to 52 keys per minute, a very high output especially when you take into account that there is absolutely no finishing work required and the keys can be transferred, already sorted, from the sorting unit directly to the assembly line. An extremely sensitive protection device of the mould guards against possible fall-outs and rejects. A film showing the working operations of the key production unit will be shown following this paper.

Messrs. Engel have designed two machines for this type of processing, namely the ES 2F 60/100 and the ES 2F 300/300. The first one has a shot weight of 55 grms and a locking force of 100 tons with an injection pressure of 1800 kg/cm². The second one has a shot weight of 200 grms and a locking force of 300 tons with an injection pressure of 2000 kg/cm².

III. Components of the two colour injection moulding machine

A) Machine construction:

The construction of the ENGEL 2F injection moulding machine types ES 2F 60/100 and ES 2F 300/300 is based on the well proven standard range of machines. They were designed and developed especially for the requirements of producers of rear and front lights for the automobile industry. They were therefore designed to be extremely robust and safe. Naturally they can be applied in other fields of plastic processing. Provision is made for a hydraulic ejector if required as well as for raw material transportation and drying units (Continator and Conevator) thereby ensuring that the best possible results are achieved when working with materials which are difficult to process.

The components of the machine can be seen in figure 3.

The mould opening and closing movements are carried out by hydraulic operated toggles. The mould height adjustment is achieved by means of a strong central gear adjustment through the tie bars and is designed for exact setting. The movement of the rotating plate is carried out by a hydramotor through a gearbox. The movement of the plate is protected against breakdown by retarded valves and safety valves as well as a locking cylinder. In addition to this the mould is guarded against damage by a mould protection device.

The injection unit comprises of two single injection units in line with the locking unit, both of which move parallel to each other. Both injection units are independent from each other with regard to times and pressure settings.

Therefore the possible application covers a very wide range.

For instance, as an alternative to the described application for the production of two colour parts, the machine can be used productively with two different moulds. Or, using different colours in the two cylinders, it is possible to inject both of them at once in the same mould. In this way very good colour contrasts can be obtained. By means of these various applications it is possible to use the machines productively even in cases where the quantities to be produced are relatively small.

B) Control:

The control unit is designed on the same principal as the one used in the standard machine. The complete control unit is installed in a separate cabinet which can be placed directly next to the machine.

The cabinet also contains the control apparatus for the cylinder heating and, when used, mould heating.

There are three types of control which can be used:

- 1) Conventional relay control**
- 2) Solid state electronic control**
- 3) Digital solid state electronic control**

The standard voltage for the relay control is 220 V and for the electronic control 24 V however other voltages can be provided if required.

The determined operating times are set by electrical - mechanical timers. Limit switches, having the same voltage as the control unit, transmit the operating signals to the control cabinet.

This type of control unit is very reliable however it must be carefully protected from dust. The contact devices such as relays and timers need replacing after approximately 2,5 to 3 million contacts.

Fault finding requires a certain amount of electrical knowledge and takes approximately 1 to 2 hours.

For that reason Messrs. Engel have been supplying machines with electronic control since 1965. At first this type of control was only supplied when specifically asked for. However by the beginning of this year the demand had grown to such an extent, that we found ourselves supplying more machines with electronic control than with the old relay type control and therefore decided to make it standard on our machines. Without a doubt the working life of the electronic control unit is very much longer than that of the relay control.

The function of the electronic unit is more or less the same as that of the relay control unit, in so far as there is the same variation of control settings. However the electrical - mechanical timers are replaced by electronic digit counters.

By the use of non-contact control the chance of breakdowns occurring has been reduced by approximately 70 %, also the time spent in finding any faults which may occur has been reduced to a minimum. The work being simplified by the inclusion of a fault finding selector switch in the system. This indicates at once, just where the breakdown has occurred.

The selector switch is installed on the back of the control unit and basically consists of a knob which can be turned to various positions, each of which represents a particular circuit in the system. If the light situated directly over the selector switch does not light up, when the circuit indicated should be operating, the fault lays in this circuit. It then takes just a matter of seconds to change the respective circuit card and the machine is once more in operation.

Once the machine is working the damaged card can be repaired at leisure without any loss of production.

Although there are quite a number of cards in the control unit, the whole system is built upon five basic cards. Thus a complete spare part kit for the control unit consists of only 5 cards.

Approximately three years ago, after receiving requests from customers, Messrs. Engel also introduced an electronic digital control system in their programme.

This control unit is basically the same as the standard solid state electronic control unit, the difference being that all operational settings are regulated on the control cabinet.

The signals for the control are transferred from the linear displacement transducers and miniature electronic proximity detectors to the logic unit. The hydraulic pressures are controlled by servo valves which are regulated from the control cabinet.

Provision has been made in the digital control machines for the next steps, by that we mean they can be hooked on to a computer if required.

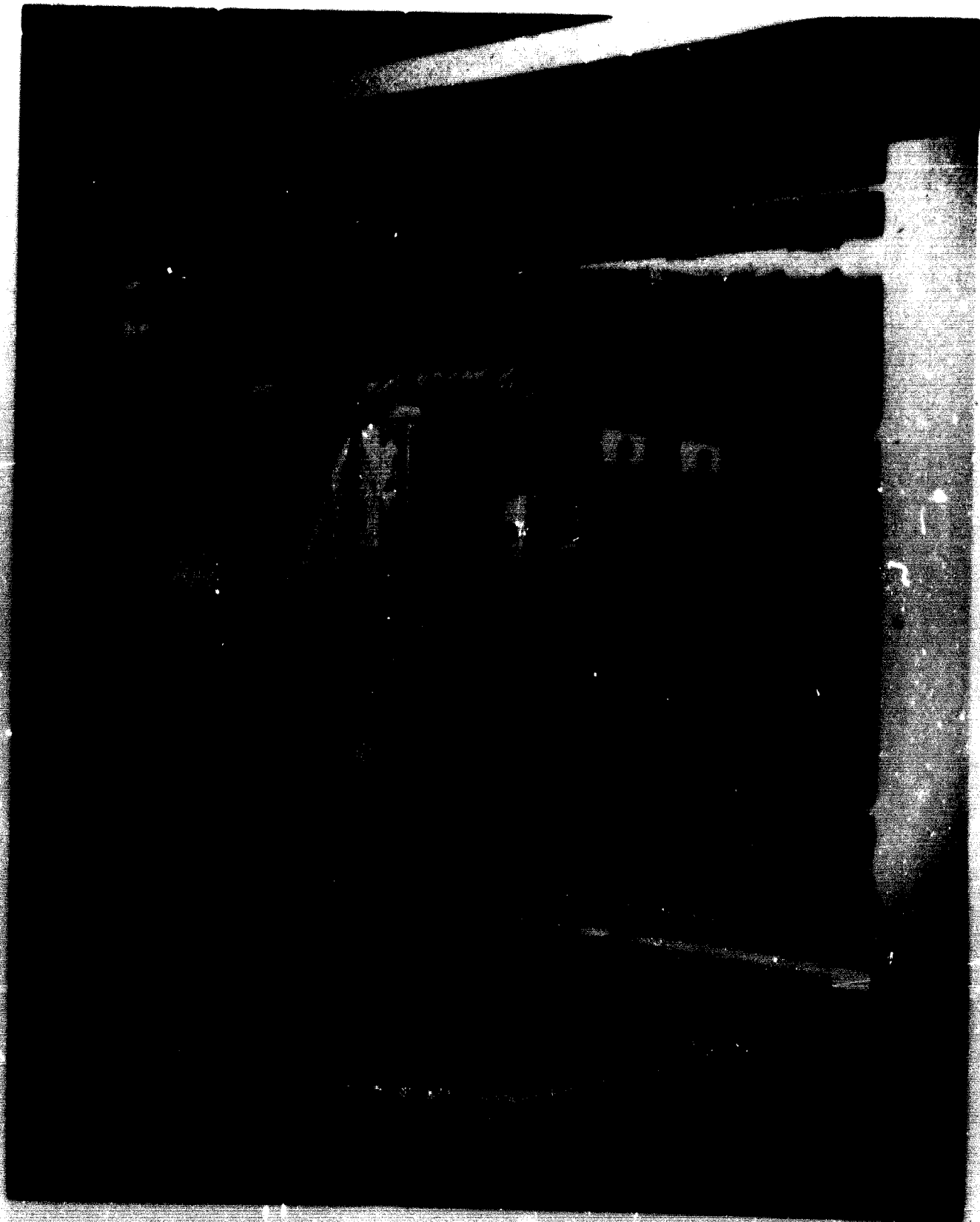
Thereby making it possible for a batch of machines to work completely alone without any supervision whatsoever.

IV. ECONOMY

The economic advantage of using a two colour injection moulding machine can be seen in the project proposal table.

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ENGEL

Two colour injection mould
for ammeter cover on ES 2F 300/300
Figure 2



ENGEL

Two colour automatic injection
moulding machine ES 2F 300/300
Figure 3





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